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TREATMENT OF STINKING SMUT IN WHEAT.

—BY—

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INTRODUCTION.

It is not the purpose of this paper to present anything new in the way of preventing smut in wheat. Many remedies have been tried, some of them giving very good results, others giving poor results, and in some cases the germinating power of the grain was destroyed. While the practice of treating seed wheat for the prevention of stinking smut is quite general in many localities, yet from the many inquiries that come to the Experiment Station in regard to smutted wheat it is evident that the treatment is not understood by all. Some growers try a good remedy but fail to obtain good results because they neglect an important detail. Others treat their seed one year with good results while the next year the same treatment may prove a failure. Such an experience is likely to discourage further effort to combat the disease. But it is safe to say that failure is always due to the remedy being improperly made or applied. The evident good results the first year may have been due to a small amount of diseased seed rather than to the treatment. The second year the disease was still unchecked by the inefficient remedy, and increased enough to cause considerable loss.

A small amount of smut in grain cannot be readily detected. Many people conclude, therefore, that their seed is free from disease and so dispense with the treatment. Many times a crop can be grown without treatment, but on the other hand a better crop might have been produced from treated seed. At any rate the farmer who treats his seed is not running any risk; he has a cheap insurance.

Before starting these experiments all available literature on the treatment of wheat for the prevention of smut

* A Senior Student in the Agricultural College. The experiments were carried on with the advice and under the direction of Professor Paddock.

was consulted. It was found that a great number of remedies have been tried, but it was hard to decide which was best. The object then in view was to obtain the best remedy that was cheap and easy to use. Many experiments have been performed with the hot water treatment. This is a good remedy but it is inconvenient to use; the water must be at just such a temperature, if below 130 F, it will not kill the smut, if above 140 F, it destroys the germinating power of the grain. Taking into account the heating of the water, the cost of this treatment is about as great as other remedies which give good results and which are much easier to use.

Smut seems to be worse some years than others. Some experimenters say that this is because of the amount of moisture in the soil, some years being so dry that all the smut spores cannot germinate. Varying amounts of moisture probably have an influence on the disease, but since the spores germinate with the grain the smut will most likely germinate if the grain does. It is of the authors' belief that variation in the amount of smut depends more upon the seed that is used. Many farmers after growing wheat free from smut a few years think it is useless to treat and consequently stop, or if they do treat, the operation is carried out very carelessly; this neglect is what gives the smut a chance, so allowing the disease to be more plentiful some years than others.

Occasional reports come to the Department from all over Colorado that smut has destroyed a whole crop of wheat, and numerous cases where the crop is badly affected. To the unobserving person this grain looks as well as any, while it is in the shock, but when the threshing time comes a large part of the supposed grain is blown on the straw pile in the form of smut spores, some of the spores lodge on the grain, and some pass out as whole kernels in which the outside covering has not been broken and is hauled off with the grain.

STINKING SMUT OF WHEAT.

(*Tilletia foeteis.*)

Stinking smut is a fungus which destroys the kernel of the wheat. This disease lives over winter in the form of spores which are microscopic in size, black in color, and globular in form. The interior of the kernel is frequently completely filled with a mass of these spores and when the outer coating is broken, as is often the case, the spores are set free and many of them lodge on the healthy grains and are held by the minute hairs which occur on the kernels at the end opposite the point of attachment.

The spores can live through very unfavorable conditions and they germinate under the same conditions as the wheat. The smut spores begin their attack as soon as the wheat grains have sprouted. The germ tubes enter the young wheat plant where they appropriate nourishment for the development of the smut plants. From this time on the two plants grow up together, the smut growing in the interior of the wheat stalk.

When the wheat stalk heads out and the kernels begin to form, the smut attacks them and absorbs the nutritive substance from the kernel. The smut then forms its seed-like spores which live over winter, and are produced only in the interior of the kernels, the glumes surrounding the kernel being unharmed. This is why smutted grain often looks healthy and well developed, but sometimes these glumes surrounding the kernel break away at the top and spread out, thus giving the head of wheat a ragged appearance. It may not be noticed that the grain contains smut until the shell of the kernel is broken and the smut spores are set free. Diseased kernels can usually be told, however, in that they are somewhat swollen and darker in color. It is known that one smutted kernel contains many thousand spores. When the grain is threshed the spores are scattered all through the grain and a crop that has but little smut one year may be nearly all smut the next year. Some grain with smut spores may fall on the ground and come up the second year as volunteer grain; this is the reason why we have smut when clean seed is planted if the same ground is seeded to wheat.

There are two kinds of smut, the Stinking Smut and Loose Smut. The Loose Smut obtains its name from the

loose-like condition which the smut is in after the spores are formed. In the loose smut the whole head of wheat is attacked, the glumes and all parts of the head are turned into a mass of smut spores which are often blown away by the wind before the grain is cut.

There are two species of Stinking Smut—*Tilletia foetens* which has the smooth spores, and *Tilletia tritici* which has spores with net-like ridges on the outer surface of the spore wall. The Stinking Smut obtains its name from its disagreeable odor, a small amount of it in the grain spoiling the flour.

THE EXTENT OF INJURY.

Stinking Smut causes more injury than is generally supposed. It has been known ever since the time of the early Greeks, but it has only been within the last ten years that very much work has been done to find a preventative. Investigations made at other Experiment Stations show that the loss may be from 1 per cent to 75 per cent of the crop. This loss is not altogether the loss of the grain, but what grain is saved can only be ground up for feed, for if it contains 15 per cent of smut it is unfit for flour. W. T. Swingle says: "There are no accurate statistics as to the amount of damage caused by these smuts. In many localities the loss is very large, and it cannot be doubted that in the whole United States it amounts to many million dollars annually."

By treating the seed every year this loss may be prevented. Smut will not appear unless the spores are planted, except what occurs on the volunteer grain, which is already in the field, caused by successive planting to wheat.

If a crop does not contain smut one year it is not a sign that the same wheat sown on the same ground will not be diseased the next year, because spores may be brought to the seed wheat by the threshing machine, or be carried by the wind and lodged on the grain. The only safe rule is to treat all seed every year. It is possible to grow a crop for several years without having smut, but in localities where it is common or where it has been and is partially stamped out, the seed should be treated every year.

METHOD OF TREATMENT.

Two methods of treatment were used in the experiment, soaking and sprinkling. The grain that was sprinkled was spread on a floor and the solution sprinkled on. The grain was shoveled over and over until all the kernels were

wet, care being taken that no more of the solution was added than was required to wet every kernel. In the soaking method the grain was placed in a tub, then the solution was added until the grain was completely covered. The mixture was stirred so every kernel came in contact with the solution and all floating kernels were removed. The grain was soaked different lengths of time, as shown in the table on page 5.

CHARACTER OF GRAIN AND SOIL.

In order to give the treatment a thorough test the worst smutted grain that could be found was used. It was so badly smutted that it had been sold for hog feed and no one would think of planting it to raise a crop of wheat. When the grain was placed in the tub to be soaked the solution was colored black by the smut spores.

The soil upon which the grain was planted raised a crop of oats the year before, and previous to that time it was used for a nursery. The soil was in very good condition to raise grain, and it certainly did not contain any smut spores.

The ground was divided into ten plats of equal size, the first and last plats were used as checks, being planted with untreated grain. All plats were seeded broadcast.

TREATMENT OF GRAIN AND RESULTS.

No. of Plats.	Treatment.	Method.	Strength of Solution.	Time.	Percent smutted Heads.
I.	Untreated				80 %
II.	Copper sulphate	Sprinkled	1 lb. to 4 gals		½ %
III.	Corrosive sublimate	Soaked	1 lb. to 50 gals	10 min	½ %
IV.	Corrosive sublimate	Sprinkled	1 lb. to 50 gals		½ %
V.	Copper sulphate	Soaked	1 lb. to 4 gals	2 min	2 %
VI.	Formalin	Sprinkled	1 lb. to 45 gals		nearly free
VII.	Potassium sulphide	Sprinkled	1 lb. to 8 gals		75 %
VIII.	Copper sulphate	Soaked	1 lb. to 24 gals	12 hrs.	5 %
IX.	Slaked lime	Mixed	1.4 lbs. to 20 lbs		50 %
X.	Untreated				80 %

DETAILS OF EXPERIMENTS AND DISCUSSION OF RESULTS.

The grain was treated March 14, 1902. When the treatment was over, all the grain excepting that treated with slaked lime, was spread out on the floor to dry. The lime and the wheat were well mixed and then placed in a conical shaped pile until planted. Three persons carefully estimated the percent of smut in the various plats.

Plat No. 1. Was planted with untreated seed. This showed that the seed was extremely smutty as eighty per cent. of the heads were diseased.

Plat No. II, planted with grain sprinkled with copper sulphate in proportion of one pound copper sulphate to four gallons of water; this gave the solution a dark blue color. One-half of one per cent. was the result. This result is much better than could be expected from the seed used.

Plat No. III. Planted with grain soaked ten minutes in a solution of corrosive sublimate in the proportion of one pound to fifty gallons of water. This gave one-half of one per cent. of the grain diseased.

Plat No. IV. Planted with grain sprinkled with corrosive sublimate in the proportion of one pound to fifty gallons of water, this gave the results of one-half of one per cent. of the grain diseased. These results prove that sprinkling is as good a method of treating as soaking.

Plat No. V. Planted with grain soaked two minutes in a solution of copper sulphate, in proportion of one pound copper sulphate to four gallons of water, giving results of one-half of one per cent. of the grain diseased.

Plat No. VI. Planted with grain sprinkled with a solution of formalin in proportion of one pound formalin to forty-five gallons of water. Scarcely a smutted head could be found in the plat. This result not only shows that formalin is a good remedy, but it also shows that the sprinkling method can be depended upon.

Plat No. VII. Planted with grain sprinkled with a solution of potassium sulphide in proportion of one pound to eight gallons of water. This gave very poor results, seventy-five per cent. smut. The solution was probably a little weak, but the result obtained shows that it could hardly be made strong enough to be a complete prevention.

Plat No. VIII. Grain soaked 12 hours in a weak solution of copper sulphate, one pound to twenty-four gallons of water. Result five per cent. of diseased wheat.

Plat No. IX. Planted with grain mixed with slaked lime in proportion of one-fourth pound lime to twenty pounds of grain, this gave poor results, fifty per cent. smut. With the use of any more lime the grain could not be sown evenly.

Plat No. X. Planted with untreated grain, the results of eighty per cent. of the grain diseased.

SUMMARY.

I. The results obtained in these experiments are remarkable because the seed used was so badly diseased. No one would think of using such grain for seed. With ordinary seed the treatments that gave the best results, would insure a crop entirely free from smut.

II. The sprinkling method proves to be as effective as the soaking method.

III. Copper sulphate, corrosive sublimate and formalin prove to be efficient remedies.

IV. Copper sulphate in a weak solution will not do good work even when allowed to soak a long time, twelve hours for instance.

V. Potassium sulphide is a very poor remedy for smut besides being expensive.

VI. Sprinkling with copper sulphate is recommended to be the best remedy. Solution, one pound of copper sulphate to four gallons of water. It is the cheapest, the handiest to use and gives as good results as any treatment tried.

VII. The smut is planted with the grain and germinates at the same time. If the seed is free from smut then the crop will be unless volunteer grain comes up in the field.

VIII. To treat the grain by the sprinkling method, place the grain in a bin large enough so the grain can be shoveled from one side to the other. Sprinkle the solution on with a common watering pot and at the same time keep shoveling the grain over and over. When the kernels are all wet the treatment is finished, but great pains must be taken to see that the work is thoroughly done.

IX. Because the grain is clean one year do not run the risk of its being free from smut the next, but treat every year.

X. The grain should not be treated very long before it is planted because it will start growing. After treatment it should be allowed free circulation of air so that it will dry quickly.

XI. The sprinkling method is by far the quickest and easiest method. If the user does not have a floor to spread the grain out while treating, a canvass, or any large cloth can be used.